MOTOROLA
Semiconductor Products Inc.

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Application Note

TRANSIENT POWER CAPABILITY OF ZENER DIODES

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Because of the sensitivity of semiconductor components to voltage transients in excess of their ratings, circuits are often designed to inhibit voltage surges in order to protect equipment from catastrophic failure. External voltage transients are imposed on power lines as a result of lightning strikes, motors, solenoids, relays or SCR switching circuits, which share the same ac source with other equipment. Internal transients can be generated within a piece of equipment by rectifier reverse recovery transients, switching of loads or transformer primaries, fuse blowing, solenoids, etc. The basic relation, v = L di/dt, describes most equipment developed transients.

ZENER DIODE CHARACTERISTICS

Zener diodes, being nearly ideal clippers (that is, they exhibit close to an infinite impedance below the clipping level and close to a short circuit above the clipping level), are often used to suppress transients. In this type of application, it is important to know the power capability of the zener for short pulse durations, since they are intolerant of excessive stress.

Some Motorola data sheets such as the ones for devices shown in TABLE I contain short pulse surge capability. However, there are many data sheets that do not contain this data and Figure 1 is presented here to supplement this information.

TABLE 1 — Transient Suppressor Diodes

Series Numbers	Steady State Power	Package	Description
1N4728	1 W	DO-41	Double Slug Glass
*1N6267	5 W	Case 41-11	Axial Lead Plastic
MPZ-5	350 W	Case 119	6 Cell Array
1N5333	5 W	Case 17	Surmetic 40
1N746/957/4371	400 mW	DO-35	Double Slug Glass
1N5221	500 mW	DO-35	Double Slug Glass
1N3821	1 W	DO-13	Axial Lead Metal

*The 1N6267 series is the latest addition to Motorola's zener transient suppressor line. These parts feature high peak power capability in a small, axial lead, plastic encapsulated package.

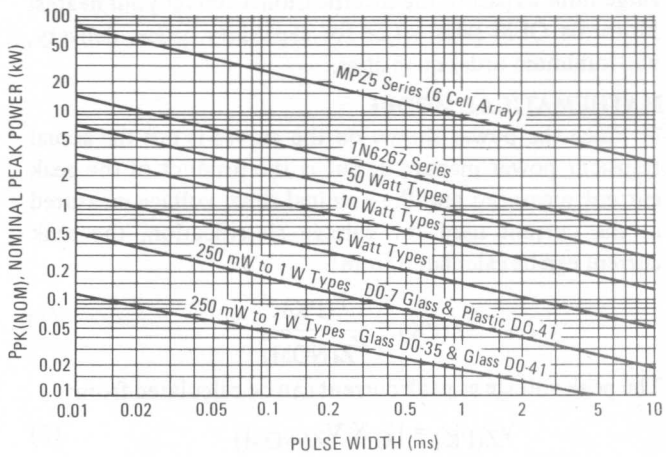

FIGURE 1 — Peak Power Ratings of Zener Diodes
Applies for non-repetitive rectangular pulses for zener voltages over 12 volts. For lower zener voltages, use 1/2 the peak power shown. Power is defined as $V_{Z(NOM)} \times I_{Z(PK)}$ where $V_{Z(NOM)}$ is the nominal zener voltage measured at the low test current used for voltage classification.

Some data sheets have surge information which differs slightly from the data shown in Figure 1. A variety of reasons exist for this:

1. The surge data may be presented in terms of actual surge power instead of nominal power.
2. Product improvements have occurred since the data sheet was published.
3. Larger dice are used, or special tests are imposed on the product to guarantee higher ratings than those shown on Figure 1. For example, the one watt 1N3821 series uses a die comparable to the 5 watt types.
4. The specifications may be based on a JEDEC registration or part number of another manufacturer.

At the limits of the various curves in Figure 1, the failure rate is less than 1 percent.